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Andersen, Maj Munch; Faria, Lourenco

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Eco-innovation Dynamics and Green Economic Change: the role of sectoral-specific patterns

Maj Munch Andersen[1], Lourenço G. D. Faria[2]

[1]mmua@dtu.dk
[2]loufa@dtu.dk

All at the Technical University of Denmark/Department of Management Engineering. Produktionstorvet Building 426. 2800 Kgs. Lyngby, Denmark.

This paper investigates the features of Green Economic Change process at the meso-level, the greening of industries. We posit that, as for "traditional" innovations, it is possible to identify sectoral eco-innovation patterns and that these represent key but neglected factors in the dynamics of green economic evolution. . The paper represents early speculative conceptual work. We have posited that, as for "general" innovations, it is possible to identify sectoral eco-innovation patterns and that these represent key but neglected factors in the dynamics of green economic chance. The paper identifies seven specific characteristics of eco-innovation which form the basis for identifying 4 core hypothesis which may explain sectoral heterogeneity and identify likely sectoral eco-innovation leaders.

1. Introduction

In this paper we seek to point out and understand the features of the Green Economic Change process at the meso-level: the greening of industries. We posit that, as for "general" innovations it is possible to identify sectoral eco-innovation patterns (Pavitt, 1984), and these represent key but neglected factors in the dynamics of green economic evolution. Multiple questions arise connected to this complex novel agenda and we offer a first contribution to future research.

The last few years have seen the rise of the 'green economy' as an established albeit still emerging business concept and policy goal (UNEP/ILO/ITUC, 2008; UNEP, 2011; United Nations & OECD, 2011). Behind the concept lies the notion that the environment increasingly is considered a business opportunity and a driver of economic development. This, however, represents a marked change compared to earlier, where the environment generally was considered a burden to business (Kemp & Andersen, 2004). Economic and environmental goals have hitherto been considered strong opposites, whether at the firm or societal level. Economic growth has been associated with continuous environmental degradation at the global level (Daly, 1974, 1995, 2008). At the firm level, undertaken eco-innovation and complying to environmental regulation has been considered an extra economic burden and something firms will only do when forced to by policy measures. A core argument of ecological economics theory and much sustainability research has been that these features represents an inherent characteristic of the capitalistic economy which will never change (Costanza et al., 2006; Daly, 1974, 1993, 1995, 2005).

Recent developments in the greening of the economy has proven these theories wrong and show the need for more dynamic evolutionary explanations, i.e. research into green economic change processes. This paper contributes to this, seeking to inquire into the industrial dynamics of the green economy. Our point of departure is that the recent rise of the green economy is more than a novel policy concept but rather reflects ongoing green economic change. We know, however, very little on the scope and nature of the green economy. The industrial dynamics of the green economic change are little understood due to the lack of indicators and theoretical and empirical research in this area.

We argue, that we may characterize the green economic change as a techno-economic paradigm (TEP), but that there are indications that the green TEP will be quite distinct in character and is likely not to follow established patterns of economic long waves and industry cycles (Andersen, 2012). Our starting assumption is that the green TEP is of such a pervasive and systemic nature that it will affect all companies and industries and cause structural change of the global economic system (Andersen, 2012). But as firms and industries are heterogeneous, they are likely to be affected differently. Our focus, then is on the adoption and diffusion patterns of green strategies and business practices by companies. The question we ask here is, in other words, how a population of interdependent companies is affected by the greening of the economy? Presuming that both vertical and horizontal industrial dynamics are important for the green economic change in this paper we choose to unfold the horizontal axis and ask further: To which degree do firms go green sectorwise? Do a few carrier industries lead the green economic process or is it a more homogeneous process? And do different industries follow the same green development curves? Overall, we aim to trace the rate and nature - degree of homogeneity - of the sectoral green economic change. Sub questions are if we can identify sectoral clustering and leaders/carrier industries and discuss which industries will be the winners and loosers in the green transformation.

From an evolutionary perspective we may, then trace how the economy is greening company by company, and industry by industry as green business models and green markets evolve and diffuse. We expect that the green economic change process as other innovations will follow a sigmoid (S-shaped, logistic) curve reflecting three phases: 1) The slow adoption by few players in the initial stages characterized by high uncertainty and high entry and transaction costs (flat curve), 2) The take off phase as the rate of adoption increases (steeper curve), and 3) The consolidation and saturation phase producing another flattening of the curve. The question is if the green economic processes may differ in character and give rise to novel innovation patterns? Is the friction to eco-innovation so high that the green economic change will not go very far?

While recognizing that these complex and quite radical economic change processes involve the co-evolution of many factors none the least the rise of new institutions, our focus here is on discussing possible sectoral patterns in the green economic change only.

Core explanatory factors are, as we shall return to, the industrial characteristics of the sector as well as its 'environmental sensitivity' (Malaman, 1996).

This paper is in an early speculative stage and raises first of all interesting questions rather than brings answers. The paper is purely conceptual, mainly due to inadequate indicators but brings in some secondary results. It aims to identify research questions and research gaps and formulate a first set of hypothesis. We argue that the issues raised in this paper may inform us importantly on possible specific conditions for eco-innovation in different industries and explain why it is easier for some industries to go green than for others. The discussion is also important to inform us on the dynamics, stages and scope of the green economy, of which we currently know surprisingly little.

The paper is contributing more fundamentally to industrial dynamics research of green economic change and to building evolutionary eco-innovation theory. The paper is structured as follows: First we discuss the specificity of eco-innovation and identify seven specific characteristics of eco-innovation which form an important basis for listing a set of key hypothesis. Second, we shortly provide some theoretical arguments which situate the green economic change in a techno-economic paradigm setting. Thirdly, we present a section on empirical findings related with sectoral patterns of eco-innovations found in the literature. Finally we bring a short conclusion.

2. Specificities of Eco-innovation and Environmental sensitivity

There has as stated been very little research into green industrial dynamics. Early in the environmental sustainability agenda the role of technology became an important issue. The seminal IPAT formula from the early 1970s states that environmental Impact is a function of Population growth, Affluence (consumption per capacity) and Technological Change (Ehrlich & Holdren, 1972; P. R. Ehrlich & Holdren, 1971). This formula has received considerable influence within ecological economics. The interest has, however, concentrated more on which of the factors to blame the most for the environmental degradation, rather than to look into the possibilities for changing the dynamics behind. Particularly the position on technology was from the beginning negative focusing on the faulty role of technology as the core cause of pollution and overconsumption. In theory it was recognized that technological change could change direction and contribute to remedying continued growth in population and consumption, but the expectation was that this would not take place. E.g. Foster refers to the conservative nature of the economic system, or as he referred to it, the 'production treadmill' (Foster, 1994). The dominating growth mania will only lead to an increasingly environmentally harmful technological trajectory where possible incremental improvements would be offset by rebound effects (Mark, 1999; McNicoll, 2001; Ehrlich & Ehrlich, 2009;Wei, 2011; Mitchell, 2012). Hence no serious attention was given to analyzing the dynamics of technological change related to the environment.

The reason for this lacking interest into the processes of technological change are quite fundamental. Mainstream economists generally only treat technological change scantly, this is also the case for ecological economists. The ecological economics agenda has been dominated by neoclassical stationary notions of the economy though this is changing somewhat in later years, influenced by industrial ecology thinking and more heterodox economic

theories. Orthodox neoclassical economics has at its core the presumption that economic decision making is a matter of constrained optimization within stationary systems of competitive equilibrium in which technological change is treated as exogenous. The static assumptions of economic rationality, full information, perfect markets and given externalities mean that environmental degradation is seen as an inherent market failure and that this condition cannot change. The costs of preserving the environment have to be enforced on companies, the primary polluters, by public regulation. As a result, competitiveness and greening are necessarily opposites. This understanding has not only penetrated environmental and economic policymaking but has also been widely shared by companies. As such it has severely hampered a shift from reactive towards proactive environmental strategies in companies and hence the development of green business models and eco-innovative capacity (Andersen, 1999, 2001, 2002, 2004; 2009; Kemp and Andersen, 2004).

Essential in evolutionary thinking is the transitory nature of innovation driven competition where entrepreneurial activity by pioneering firms and industries is followed by swarms of imitators leading towards a cyclical economic development (Schumpeter, 1939). These thoughts have been further developed into models of economy-wide techno-economic paradigm changes (TEP), where a major techno- organizational breakthrough leads to long waves in the economy (Freeman, 1991; PEREZ, 1983, 2010). The greening of the economy, it is here suggested, should be seen as such an economy-wide techno-economic paradigm change, as pointed to be several researchers but not analyzed in depth so far, neither conceptually nor empirically (e.g. Kemp & Soete 1992; Freeman 1994; 1996; Perez, 2013). We argue that green economic evolution follows similar dynamics as other cases of TEP but that there are specific characteristics of eco-innovative activities, which make it likely that the green TEP may unfold somewhat differently from the others. A TEP is characterized by the penetration of novel premises for economic activity which means that each TEP will be distinct and lay the foundations for the next TEP. While some environmental research tend implicitly to presume that eco-innovation and environmental sustainability is the first radical systemic change of the economy this is far from the case. Evolutionary economic research has so far identified four to five successive TEPs (Freeman, 1987, 1991; Archibugi, 2001; Freeman and Louca, 2001), with the green TEP as well as biotech and/or nanotechnology as upcoming possible TEPs (Chris Freeman, 1994, 1996b; Andersen, 1999, 2012; Perez, 2010, 2013). This discussion emphasizes the cumulative nature of innovation, the longevity of changing direction in technology and the 'creative destruction' and learning it entails in many respects.

Behind the TEP discussion lies the notion that each TEP era facilitates the evolution or dominance of a new or distinct type of innovating firms. Again, Pavitt's seminal taxonomy on sectoral patterns of innovation may contribute to our understanding of the link between meso and macroeconomic development. The standard definition of an industry is an aggregation of firms with a shared output. Many additional categorizations of industries exist, however, illustrating the fact that the notion of a sector is not so clear cut. Pavitts taxonomy may in fact contribute more to explaining patterns in innovating firms related to changes in the competitive conditions change rather than patterns in sectoral behavior (Archibugi 2001). We propose here the latter interpretation, arguing that the green economy is characterized by a new type of value based competition, where it is firms ability to profile themselves on their environmental performance and identify the new green business opportunities which is becoming a central competitive factor.

Figure 1 below seeks to illustrate the parallel long term evolution of companies' innovative activities with economic activity. We argue further that the green economy is characterized by more narrative competition where the complex environmental messages can only be communicated via social media and supported by standards, whereas price regulation becomes less central, and firms increasingly compete on other factors than costs.

We are not interested in identified a few core carrier industries of the green TEP, and it is so far also highly uncertain which the carrier industries are going to be given the very pervasive nature of the green TEP. It is likely though that ICT, biotech and nanotech will play important enabling durable roles for eco-innovation also in the long run.

Here, we are rather interested in identifying more detailed sectoral patterns in eco-innovative activities in the economy in order to understand how the conditions for eco-innovation may vary across industries and over time as more and more firms are caught up by the green economic process. But the TEP concept is important none the less as it puts the green economic change into an important historical context and allows us to discuss how the green economy and the related clean tech revolution may possibly effect the industrial organization and favour some type of companies while creatively destroy others. It allows us also to raise the question to what degree the green TEP will rejuvenate the economy and hence represent discontinuity or whether the economic impacts will only be minor.

Period	Successive Techno-economic Paradigms	Industrial organization	Typical industries & Innovations	Rise of Pavitt's category of firms
1770-1830	Early mechanization	Growing importance of small manufacturing firms	Textiles, Potteries, Machinery	Supplier dominated
1840-1880	Steam power and railway	Separation between producers of capital and consumption goods	Mechanical engineering, steel and coal	Specialized producers
1890-1930	Opportunities associated to scientific discoveries	Emergence of large firms	Chemicals, Electrical machinery, Engineering	Science based
1940-1980	Fordist and Taylorist revolutions	Oligopolistic competition for mass consumption	Automobiles, Synthetic products, Consumer durables	Scale intensive
1990-200?	Information and communication Economy	Networks of firms, strong user-producer interactions	Microelectronics, Telecoms, Software	Information intensive
2006-	Green Economy, circular revolution	Narrative competition based on social media, circular organization of production and consumption	ICT, nano and biotech, smart systemic solutions	Value based

Source: own elaboration.

Figure 1. TEP & innovative patterns of industries.

In order to understand possible sectoral patterns related to eco-innovation we need to define eco-innovation and discuss its specificities. Eco-innovation is here defined as 'innovations which aim to or are able to create green value on the market'. This definition differs importantly from other definitions of eco-innovation/sustainable innovation/clean tech in emphasizing economic rather than technical aspects (Andersen, 2008, 2012).The definition captures two key issues of the green economic evolution: A) when firms consciously pursue eco-innovation strategies and B) when the market recognizes a green product or rewards a companies' green profile. Also, it is a dynamic definition, recognizing that greening is a moving target (Kemp & Andersen, 2004), in contrast to more absolute definitions.

Basically, there are two main types of eco-innovations as also referred to by Eurostat. The environmental sector (involved with environmental remediation) and the innovations which are greener than the alternatives . Here we focus on the latter large group. The green profit opportunities lie in either increases resource productivity and waste handling savings (process eco-innovations) or in using the green characteristics as a selection criterion, possible attracting a green premium price(product eco-innovations) (Andersen, 2008).

It goes beyond this paper to go into further discussion of eco-innovation taxonomies . We restrict ourselves to bring a list of 8 core characteristics of eco-innovation which provide important inputs for the theoretical discussion afterwards:

Eco-innovations are characterized by:

1. Being extraordinarily systemic (value chain/life cycle assessment, recycling, SCP).
2. Having unusually high information costs (credence characteristics, relativity, complexity)
3. Having a strong normative element (inherently good to be green).
4. Being more open.
5. The environmental potential is in part technology dependent.
6. The technical infrastructure and physical planning is important.
7. Policies play a very high role.
8. The carrying capacity/resilience of the local biosystem matters.

Before discussing these in more detail in the section below, let us comment briefly on the implications of this for our discussion on the dynamics of sectoral eco-innovation and its relation to the rate and direction/homogeneity of green economic change. The effect of these characteristics is that there are induced and related innovations vertically and horizontally which lead to expansionary processes, as more and more firms are pulled into the green economic process (Andersen, 2012; Andersen, 1999). There are thus strong multiplier effects to green economic change. But another central effect of the characteristics is very high dynamic transaction costs to greening, particular in the early phases.

We may conclude from this that two (reciprocal but related) processes are at work. The latter argument should entail much friction to eco-innovation,

supported by the lock-in into none green practices, strategies and mindsets that have persevered for 50 years (since the start of environmental regulation in the 1940-50s), which is well documented in much empirical eco-innovation research (Kemp 2009). This should lead to a long gestation period and a slow heterogeneous move up the green S-curve where the green laggard industries function as bottlenecks to green economic change.
The former argument, on the other hand, should entail a relatively fast homogenous move up the green S-curve, as companies, supported by widespread policies, relatively fast pull each other into the green economic process.
Realizing that both arguments hold some relevance, further theoretical and empirical argumentation is needed.

2.1 Hypothesis on sectoral eco-innovation

In this section we will refer to the above eco-innovation characteristics by their number ,e.g. C1, C4.. Earlier it has been argued that the greening process is an unusually uneven economic process (Andersen, 1999). Different sectors are characterized by differences in their 'environmental sensitivity' (Malaman, 1996). In an early empirical quantitative study on eco-innovation in Italy, Malaman argued that different sectors are characterized by differences in their 'environmental sensitivity' (Malaman, 1996) which he saw as related to the degree of environmental impact produced. The more polluting industries are seen as the more environmental sensitive as they are subject to more environmental regulation. While this argument is well supported by other research (**) we would like to expand the notion of sectoral environmental sensitivity. While regulation is a core driver particularly of early phases of eco-innovation, compare C7, reputation is an important driver of market driven eco-innovation, compare C3. We would like also to include positive business opportunities among the environmental sensitivity argumentation. Some industries technology base and products happens to be environmentally benign. This may though not be absolutely but is also subject to change as the green agenda changes; an example is wood houses which in the current circular economy agenda emphasizing resource efficiency and recovery is considered a green product which it wasn't ten years ago.

In suggesting hypothesis for explaining sectoral patterns of eco-innovation we are looking for possible structural explanations rather than historic, which certainly may matter too, recognizing the high importance of policy making and thereby institutions for eco-innovation. Never the less we suggest the following core hypotheses (there are a number of other less important not included here):

The pioneering/most green industries, which are also the most environmentally sensitive, are:

1) The most polluting (technological characteristics)
    a. Industries with a green reputation problem
2) Industries with many large companies (resources, brand)
    a. Industries with long term strategies (capital intensive)
3) Industries whose products are 'evidently' green or where early green market standards are in place
4) Industries close to the consumer/with life style products (reputation explanation)

Ad 1.We argue that the most polluting industries are among the pioneers and todays leaders. This is largely a technological characteristics as some industries are inherently more polluting than others. Indeed changing the technology base into something environmentally benign is a core challenge for all industries in the green economy but easier to achieve for some indsutries than others, The long exposure to environmental regulation has caused longterm learning and competence building, often including the introduction of environmental management systems,which the industries less subjected to regulation have not experienced. Some industries have experienced severe green reputation problems which either lead to defensive or proactive green strategies (especially more lately representing a more mature stage of green economic change..

Ad. 2. Industries with many large companies are among the green leaders. The big companies are core green eco-innovators and market makers because they have the sufficient resources to undertake the demanding work, compare the high information and transaction costs related to C1c and C2. Also thye have the largest reputation need, compare C 3. The big companies have to invest heavily in green standards and certifications to verify their green credibility which key processes isn the green neconomic change. Also, it is the biuggest industries which are among the most capital intensive industries which typically dominate in industries with long term strategies, such as pharmaceuticals, which are well aligned with long term green strategizing.

Ad. 3. Industries whose products are 'evidently' green or where early green market standards are in place address the problem of market penetration for green products. Green markets are often still poorly functioning. The industries whose product appear evidently green or which are recognized as green ikons, the bicycle,

recycled paper, windmills, have good conditions for product eco-innovation, or where green information standards are well developed such as in personal care products but lakcicng in many othe product areas such as construction, compare C2, and C3, as firm have to avoid being accused of 'green washing'.

Ad. 4 Industries close to the consumer/with life style products typically have more attention to the greening of a product such as personal care products, and electronic equipment, compare C3.

3. An integrated view of the interplay between industry characteristics and environmental sensitivity

By combining the insights on sectoral patterns from industry characteristics and environmental specificities, our aim is to discuss how sectoral patterns of eco-innovations differ from sectoral patterns of "traditional" innovations. Some recent studies focus on how industrial characteristics affect and are affected by environmental issues. In this sense, we can point out some of the main debates within the existing literature on eco-innovation dynamics.

Firstly, we discuss the relationship between technological characteristics and environmental sensitivity. The transition to a green economy requires the adaptation of most human activities, including transportation, manufacturing, services, resources and energy production. To the industry, this means that firms' products and productive processes have to be replaced or adapted in a greater or lesser extent, depending on their net environmental impact. Mature industries may have to develop solutions that are beyond the possibilities offered by current dominant designs. Due to its depth and scope, the green transition has the potential to induce major transformations which may also affect sectoral patterns of innovative activity, even being a source of de-maturity processes, leading to increasing technology experimentation and firm-level heterogeneity.

It is argued in the literature that eco-innovations respond differently to technological capabilities and resources when compared with normal innovations, and therefore the complexity level of "green technologies" can differ across sector as result of specific environmental "challenges" that are influenced by the environmental sensitivity, such as compliance of environmental goals with existing and emerging technologies and technological competences, the role of suppliers as green technology providers, among other factors.

Because environmental issues have been historically regarded as marginal concerns along existing techno-economic paradigms, it is expected that, in order to achieve their environmental goals, many sectors would have to radically change their technologies and consequently their core technological competences. In these sectors, eco-innovations tend to be more complex and rely on different knowledge sources. In fact, many authors argue that eco-innovations in general tend to rely more on external sources of knowledge and information compared to other innovations (Belin et al., 2009; Horbach et al., 2012; Rennings & Rammer, 2011), and therefore firms that realize eco-innovations would be more likely to cooperate with other actors (Cainelli et al. 2010).

Several studies point out the effects of firm size on eco-innovation opportunities through, for instance, their access to higher amounts of financial and human resources, their existing innovation al., 2000; Rehfeld et al., 2007; Greening & Gray, 1994), while other studies do not support this claim (Wagner, 2008; Engels, 2008). According to Brunnermeier & Cohen (2003), the international competitiveness and size are indeed significantly correlated with eco-innovative activities.

However, we argue that this is not true for all sectors: it depends on the "fit" between existing technological characteristics and competences and environmental goals, both subject to sectoral specificities. Moreover, such fit tends to be unstable over time, since both industrial characteristics and environmental sensitivity are in constant change. Fankhauser et al., (2013) suggest that the competitive advantages that some sectors and/or countries have today may be not sufficient in the future, as many of them "(…) lag behind in terms of green conversion" (p. 902). However, the existing market shares and capabilities can play an important role to firms green competitiveness. For instance, they found that some sectors (i.e. engines and turbines, and motor vehicles) present a positive relationship between eco-innovation and existing, country-specific competitive advantages – so far, highlighting the role of the existing sectoral structure to foster eco-innovation activity. In these sectors, they expect no major changes on competitive structure as result of "green conversion". In electricity distribution and electric motors/generators/transformers, however, relatively weak players from Korea, the UK and US – that however have strong eco-innovation capabilities – could be able to be leaders in the future.

The competitive conditions also have an impact on eco-innovations. (Rothenberg & Zyglidopoulos, 2007) discuss two dimensions of competitive conditions affecting eco-innovative activity. First, sectors characterized by highly competitive conditions and low munificence - the capacity of sustaining resources (i.e. demand, natural and financial resources) for one or more firms to survive and growth - tend to develop a short-term mentality and avoid experimentation along technologies for which firms do not possess capabilities, as the amount of resources available must be invested in critical areas of operation (Zyglidopoulos, 1999). In this sense, firms operating in such environments are expected to avoid investing in eco-innovations that do not offer competitive advantages on the short-term. On the other hand, high munificence conditions open space to long-term technological planning, including investments on eco-

innovations (Carter & Dresner, 2001). Secondly, highly dynamic markets (which bring on uncertainty about future competitive and technological conditions) induce firms to consider alternative technologic pathways (Buchko, 1994), making them more open to invest on eco-innovation development (Aragon-Correa & Sharma, 2003; Koberg et al., 2003).

The role of institutions - especially regulations and organizational configurations – on eco-innovation activities is one of the most well studied dimensions of eco-innovation literature. The Porter hypothesis (Porter & van der Linde, 1995) is usually mentioned, once "…properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them" (p. 98). Other factors discussed on the literature include the effects of anticipation of future regulation and regulatory stringency on the generation of eco-innovation opportunities (Ambec et al., 2013; Jaffe & Palmer, 1997; Nameroff et al., 2004). However, little is said about the role of sector-specific institutions on eco-innovation activity. As Dolata (2009) states, however, institutionalized mechanisms can exert important effects on technological changing: "while some sectoral systems and its established actors may, at an early stage, ignore and underestimate even serious technological challenges, others may possess institutionalized mechanisms that even facilitate path-deviant transformations." (pp. 1067).

Furthermore, new organizational configurations can emerge from the investment in eco-innovations: according to Horbach et al. (2012), eco-innovative activities are related with new forms of labor organization and supply chain management. Also in this case, sectoral patterns can generate different results: Marin & Mazzanti (2013) believe that the relationship between environmental efficiency and labor productivity - one of the main sources of both economic and environmental gains that characterizes the concept of eco-innovation adopted here - differs across manufacturing sectors, "(…) underlining different eco-innovation opportunities of different branches, different reactions to [policy] events and different structural changes in production and energy processes" (p. 40).

Finally, the literature also points out the specificities of non-manufacturing sectors, following similar ideas applied to non-environmental innovations (Castellacci, 2008; Evangelista, 2000). According to Cainelli & Mazzanti (2013), service industries are subject to less strict environmental regulations and economic instruments because of their relative low impact on the environment, and these differences could impact the eco-innovation performance. They found that "(…) the drivers of EI [environmental innovation] differ across service industries, with an important role played by cooperation, training, environmental management systems and public funding" (p. 1602).

4. Conclusions

Within evolutionary theory, many scholars have demonstrated how some elements of selection environments – e.g. innovation sources, demand and technology characteristics, and institutions - are constrained by sectoral boundaries, indicating that firms could be subject to some convergence along sectoral patterns of innovation. We posit that, as for "general" innovations it is possible to identify sectoral eco-innovation patterns, and these represent key but neglected factors in the dynamics of green economic evolution. Multiple questions arise connected to this complex novel agenda and we offer a first contribution to future research.

The paper identifies seven specific characteristics of eco-innovation which form the basis for identifying 4 core hypothesis which may explain sectoral heterogeneity and identify likely sectoral eco-innovation leaders. Moreover, some of the empirical findings on the literature were used to discuss how sectoral patterns of eco-innovation arise. The paper represents early speculative conceptual work, and we have to recognize that, although very interesting as potential research topic, analysing sectoral patterns of eco-innovation requires an extra effort to generate reliable and comprehensive indicators on a meso-level.

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